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ADOPTION OF GREEN BUILDINGS IN PAKISTAN TO ACHIEVE PAKISTAN'S NATIONALLY DETERMINED CONTRIBUTION

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Review Analysis on data related to the Pakistan Green Building Certification System- Energy Expert

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SUMMARY

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. In a rapidly urbanizing nation of approximately 230 million people, where the construction sector significantly contributes to energy consumption and greenhouse gas emissions, the need for green buildings is extremely critical. The transition to green construction not only aligns with global sustainability practices but also contributes to energy conservation, reduced GHG emissions, and improved living conditions in Pakistan. This report highlights the energy-efficient building practices and challenges in Pakistan, highlighting country's nascent yet much needed transition towards sustainable construction practices. The work navigates through various aspects of green building adoption, including the regulatory landscape, challenges, global comparisons, and technology integration, with a focus on Pakistan's unique climate and building typologies.

Challenges in Green Building Adoption in Pakistan

Pakistan faces several challenges in embracing green building or energy efficient practices due to weak implementation frameworks for building energy codes, limited access to eco-friendly construction materials, shortage of skilled and qualified labor force, high costs associated with low-carbon construction techniques, and the predominance of subpar construction practices, particularly in rural areas. Moreover, there's a lack of awareness about the benefits of green building, and the absence of comprehensive guidelines and policies promoting green construction.

Regulatory Landscape and Governance Structure

The report highlights and provides insights into the governance structure and building regulations in Pakistan indicating the multiple stakeholders at the national, provincial and district levels involved in policy-making and implementation. One of the key areas for intervention is need for enhanced capacity development and robust enforcement mechanisms for implementing stakeholders.

Building Energy Codes

Pakistan's journey in developing and implementing building energy codes is explored, from the establishment of the first Energy Building Code in 1990 to the recent Energy Conservation Building Code 2023. The report emphasizes that these codes are yet to gain widespread adoption at the local government level while citing barriers like legal, regulatory, technical, institutional and financial challenges.

Green Building Technologies

Various green building technologies applicable to Pakistan's hot climate are discussed concentrating on sustainable construction materials, green insulation, efficient windows, cool roofs, low-emitting materials, efficient HVAC systems, solar panels, automation, efficient lighting, and water conservation. It also underscores the cost considerations for the majority of consumers and the need for a skilled workforce to effectively implement these technologies.

Building Envelope and Energy Efficiency

The role of the building envelope in ensuring energy efficiency is underscored while emphasizing the importance of thermal resistance, vapor control, effective seals, and airflow control.

1: BACKGROUND

The building and construction sectors, collectively responsible for approximately 38% of greenhouse gas (GHG) emissions and accounting for 35% of total energy consumption.[1] Developing nations, including Pakistan, are witnessing growing populations and increasing income levels. As a result, the demand for construction and infrastructure development continues its upward trajectory, leading to a surge in GHG emissions within the construction and building sector.

Pakistan's building sector significantly contributes to the nation's energy landscape, accounting for 23% of total energy consumption and a substantial 54% of the country's electricity consumption.[2] Remarkably, the building sector (residential, commercial, and public) of Pakistan is continuously growing for the past two decades, representing a compound annual growth rate of 12.3%. This surge in demand could be attributed to rapid urbanization, resulting in increased construction activity and rising living standards.

While, the construction sector made a substantial contribution to Pakistan's GDP in FY22, amounting to approximately PKR 1,848 billion. This marks a notable growth of around 31.1% compared to the previous fiscal year when it contributed PKR 1,409 billion. On average, the construction sector's contribution to the Pakistan's GDP stands at around 3%.[3]

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. Green buildings present a holistic approach that prioritizes environmentally friendly materials and processes, while carefully minimizing resource utilization across each phase—from design, and construction to operations and eventual demolition.

This report serves as a review of the current landscape of building construction practices, regulations, standards, and policies in Pakistan. It also delves into barriers impeding the widespread adoption of energy buildings codes within the country and outlines a strategic pathway for their effective implementation. Despite the implementation of various policies and regulatory measures, including the introduction of building energy codes, the adoption of energy-efficient and green building practices remains in its early stages in Pakistan.

The major barriers to effectively adopting energy efficient and green building practices in Pakistan are weak enforcement of building energy codes, lack of awareness of potential benefits, high upfront costs, limited access to environmentally friendly construction materials and a shortage of skilled workers. These challenges are compounded by the higher upfront costs associated with low-carbon construction methods and technologies.

It is within this context that the role of green buildings assumes vital importance, exceeding both economic and environmental perspectives. This align perfectly with Pakistan's ambitious objectives of

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[1] Azhgaliyeva, Dina. and Rahut, D. B., "Promoting Green Buildings: Barriers, Solutions, and Policies", (ADB Report 2022), https://www.adb.org/sites/default/files/publication/812801/adbi-wp1331.pdf

2 National Energy Efficiency and Conservation Authority (NEECA), "Energy Conservation and Building Codes 2023"

3 The Pakistan Credit Rating Agency Limited, "Construction Sector Study, (PACRA 2023) https://www.pacra.com/sector_research/Construction%20-%20PACRA%20Research%20-%20Mar'23_1680249473.pdf

attaining low carbon growth, as outlined in the Pakistan's Nationally Determined Contributions (NDCs). As Pakistan deals with the multifaceted challenges posed by its demographic changes and growing energy demands, the adoption of green building practices emerges as an opportunity for sustainable progress and harmonious coexistence with the environment.

However, it is also important to acknowledge the ground realities that the construction landscape in Pakistan, particularly in rural areas in most part diverges from established engineering design, construction norms, and standards. This has led to a proliferation of low-quality construction and buildings throughout the country.

Housing in Pakistan can be broadly categorized into three classes: "pukka" houses, which are constructed using substantial and durable materials such as stone, brick, cement, concrete, or timber; "kuchha" houses, characterized by their use of less-durable materials like mud, bamboo, reeds, or thatch, constituting approximately 35% of housing stock; and "semi-pukka" houses (11%), which represent a blend between the two categories. Among these, the better-quality "pukka" houses make up approximately 54% of the total.[4]

Even in urban areas, ramshackle neighborhoods, locally known as "katchi abadis," dominate the landscape and can be found in metropolitan cities across the country.[5] These areas typically lack proper planning and regulation, leading to a dearth of safe drinking water, adequate sanitation facilities (similar to rural areas), and buildings that often exhibit structural weaknesses and safety hazards. Alarmingly, approximately half of all urban residents in Pakistan are residing in such unplanned and underserved areas.

Addressing the disparities in construction practices and housing quality, especially in rural and informal urban settlements, remains a pressing challenge. The promotion of sustainable and green building practices, coupled with improved urban planning and infrastructure development, stands as a crucial step towards ensuring safer and more resilient living conditions for a significant portion of Pakistan's population.

2. GREEN BUILDINGS OVERVIEW

Green building is a holistic concept rooted in the understanding that the built environment can profoundly impact the natural world and its occupants. It strives to amplify positive effects and mitigate negative ones throughout a building's entire life cycle.[6]

GREEN BUILDINGS AND THEIR CORE PRINCIPLES

Green building, also known as sustainable or high-performance building, represents the practice of developing structures and employing processes that prioritize environmental responsibility and

[4] Pakistan Bureau of Statistics, “Housing Units by number of rooms and type” https://www.pbs.gov.pk/sites/default/files/tables/housing/HOUSING%20UNITS%20BY%20NUMBER%20OF%20ROOMS%20AND%20TYPE.pdf

[5] Britannica “Housing in Pakistan” https://www.britannica.com/place/Pakistan/Daily-life-and-social-customs

[6] US Green Building Council, ‘What is green building?”, (USGBC 2014) https://www.usgbc.org/articles/what-green-building

resource efficiency.[7] This approach spans the entire life cycle of a building, from initial site selection to design, construction, operation, maintenance, renovation, and eventual demolition. It expands upon and complements the traditional building design considerations of cost-effectiveness, utility, durability, and occupant comfort.

It is important to note that energy efficiency is the first step to green building, and as a principle all green properties should be energy efficient.[8] Green buildings incorporate a range of environmentally friendly and resource-efficient measures throughout their life cycle. The overarching goal of this concept is to minimize a building's negative impact on the environment while maximizing its positive contributions to both the natural surroundings and the well-being of the people who inhabit it. This holistic approach not only supports sustainability but also fosters a healthy built environment. Key areas of emphasis in green building practices include the efficient use of energy, water, and other resources, ensuring high indoor environmental quality, and minimizing adverse impacts on the natural environment.

Broadly, green building adheres to planning, design, construction, and operations with following key considerations:

- Prioritize **energy efficiency** and energy-saving technologies and renewable sources.
- Promote **water conservation,** minimizing water use and often incorporating sustainable water management.
- Improve **Indoor Environmental Quality** by enhancing air quality, daylight, and thermal comfort.
- Utilize **Sustainable Construction Materials** while choosing eco-friendly, and locally sourced materials.
- Reduce **environmental impact** and preserving natural surroundings.

Thus, a green building goes beyond construction, promoting sustainability, resource efficiency, and a healthier living environment.

GREEN BUILDINGS VS. ENERGY-EFFICIENT VS. TRADITIONAL: WHAT SETS THEM APART?

Distinguishing between traditional building, energy-efficient and green buildings is important to understand the core principles construction approach and align sustainability goals. Green buildings, energy-efficient buildings, and traditional buildings differ significantly in their approach to construction and their impact on the environment. Green buildings provide a broad spectrum of sustainable practices that extend beyond energy efficiency, while energy-efficient buildings primarily

[7] US Environmental Protection Agency, "Green Buildings" (US EPA 2016), https://archive.epa.gov/greenbuilding/web/html/about.html.

[8] Energy Star, "Green Buildings and ENERGY STAR" https://www.energystar.gov/buildings/about_us/green_buildings_and_energy_star#:~:text=According%20to%20the%20World%20Green,ensure%20that%20we%20can%20harness

focus on minimizing energy consumption. Whereas traditional buildings lack the sustainability features and efficiency measures found in both green and energy-efficient buildings.

Figure 1: Traditional buildings, energy efficient buildings and green buildings (Source: author)

Green Buildings

Green or Sustainable buildings incorporate holistic approach to reduce their environmental footprint throughout their entire life cycle. While energy efficiency is a significant consideration, green buildings go beyond this and include a range of environmental aspects, including water efficiency, waste management. Green buildings predominantly use sustainable materials in construction and take into consideration for the building's overall impact on the natural environment. Green buildings also prioritize the well-being of occupants, indoor air quality, and minimizing resource consumption for more sustainable and environmentally responsible.

Energy Efficient Buildings

While the entire focus of energy-efficient buildings is to reduce energy consumption and promote efficient energy use. They typically employ efficient technologies and strategies to optimize heating, cooling, lighting and cooking. While these buildings contribute to environmental sustainability by reducing GHG emission and lowering energy costs, their scope is limited in comparison to green buildings. Hence, energy-efficient buildings may not necessarily address other critical environmental concerns like material sourcing.

Traditional Buildings

Traditional or conventional buildings typically follow established practices without specific considerations for sustainability. While they serve their intended purposes, they tend to be less environmentally friendly compared to green or energy-efficient buildings. Traditional buildings may rely on older, less efficient technologies and materials, resulting in higher energy consumption and a larger environmental impact over their lifespan.

GLOBAL LANDSCAPE OF GREEN BUILDINGS

Green building practices have gained significant traction worldwide. With rising concerns of climate change and sustainability considerations, countries across the globe are embracing sustainability practices in construction. While many countries are widely adopting green building practices, it's important to highlight that USA, Europe, China, and India have achieve significant progress in this areas. Over the last few years, the investments in energy efficiency has seen significant growth with an annual investments amounting to over US$ 250 as highlighted in the Figure 2 below.

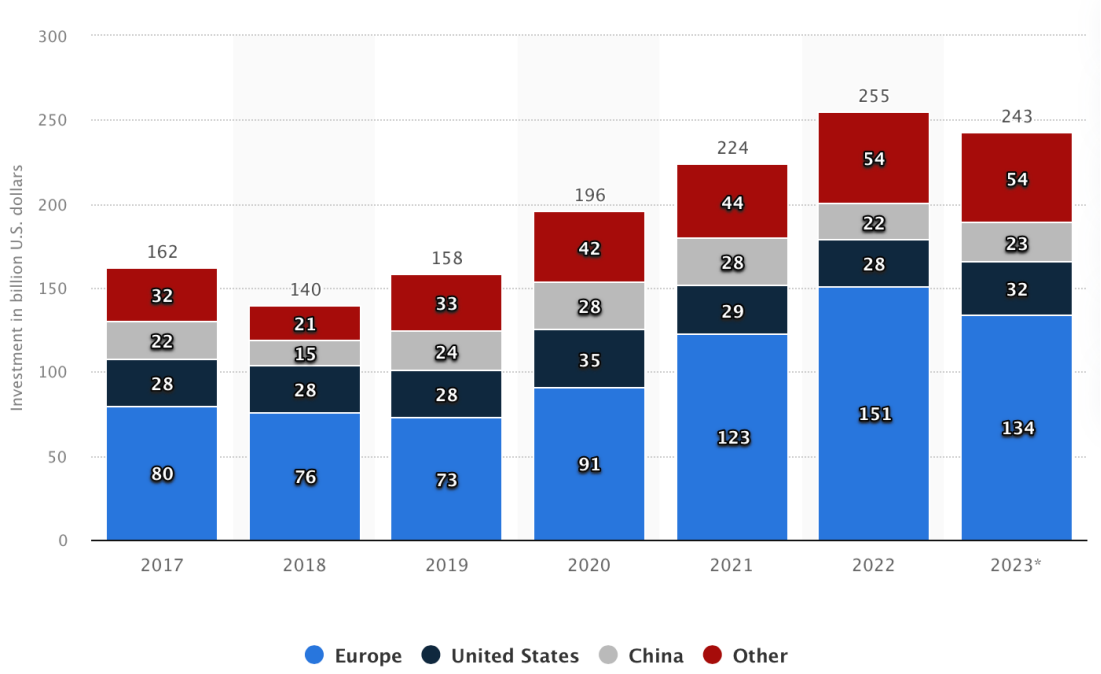


Figure 2: Annual investment in energy efficiency in the buildings sector worldwide from 2017 to 2023, in Europe, U.S. China (Source: Statista 2023)

U.S.A

The United States is the world leader in green buildings by a significant margin. The US has been pioneering and has taken the lead in green building initiatives, thanks to organizations such as the U.S. Green Building Council (USGBC) and their successful implementation of the LEED (Leadership in Energy and Environmental Design) certification system.[9] LEED has become a global standard for sustainable building practices, focusing on energy efficiency, water conservation, and indoor air quality.[10] The US is proud of its diverse range of LEED-certified projects, covering residential, commercial, and public sectors.

The growth of the green building market in the United States is primarily driven by several key factors, including a progressive increase in regulations at the local, state, and federal levels, attractive financial

[9] Building Design Construction Network, "The countries with most green buildings" (2021) https://www.bdcnetwork.com/countries-most-green-buildings

[10] US Green Building Council (USGBC), "LEED rating system", (2022) https://www.usgbc.org/leed#:~:text=LEED%20(Leadership%20in%20Energy%20and,rating%20system%20in%20the%20world.

incentives for building developers and owners, and the active role of the U.S. government in promoting sustainable development practices and reducing carbon emissions. While for the end users, operating cost savings, shorter payback periods and increased asset value in new green buildings and green retrofits are reported to be the key triggers.[11]

CHINA

China has undergone substantial urbanization and economic expansion, resulting in a substantial increase in its building stock. Since 2006, the Chinese government has been promoting green buildings by implementing various measures, including providing information, enhancing skills, setting clear goals and regulations, offering financial incentives, and presenting examples of successful green buildings. The table 1 below outlines some of the main policies in practice to encourage green building development in China.

Table 1: Key policies regarding green buildings in China.[12]

Year	Policies	Key Content
2006	Green building standard (1st version)	Defining green buildings, with six categories of criteria
2007	Measures for green building labeling	Defining different levels of green buildings, i.e., 1-, 2-, and 3-star (low to high)
2012	Implementation advice for accelerating green building development	A first-of-its-kind green building policy issued by the central government (rather than a ministry policy document): accelerating green building development and establishing the overall policy framework of green building development, especially, specifying financial incentives to promote green buildings.
2013	National action plan for green building development	Issued by the central government: Defining national targets of green building development, key tasks, and support mechanisms. The green building development target became an evaluation criterion for local government performance.
2014	Green building standard (2nd version)	Creating two types of labels for design and operation. The former is certified if the design of a specific building fulfills green building criteria, while the latter is certified after a building has been in use for a year. In addition, the Standard introduced detailed scores for different "green" categories.
2019	Green building standard (3rd version)	Redefining the key principles of green buildings: "human-centered and high quality of life" instead of an exclusive focus on environmental sustainability; creating new criteria based on this new principle; green buildings certified only after construction is complete; including a basic level as another level of green building label (four levels)

INDIA

Green buildings are a growing trend in India. According to the US Green Building Council, India has the

[11] US Green Building Council (USGBC), "Economic benefits of green buildings", https://www.usgbc.org/press/benefits-of-green-building#:~:text=The%20top%20two%20triggers%20for,retrofits%20have%20been%20consistently%20reported.

[12] Azhgaliyeva, Dina. and Rahut, D. B., "Promoting Green Buildings: Barriers, Solutions, and Policies", (ADB Report 2022), https://www.adb.org/sites/default/files/publication/812801/adbi-wp1331.pdf

second highest number of green buildings outside of the US region, following only China. It is expected to become more popular as the country moves towards a sustainable future. To promote green buildings, the government has set up various incentives and promotion schemes. The National Buildings Code of India (NBCI) and Energy Conservation Building Code (ECBC) are few of them. These measures aim to promote high-performance and energy-efficient buildings in India. The Indian government provides several incentives to encourage green building and LEED certifications in India[13]. Some examples include:

- **Tax benefits -** The Indian government offers tax benefits to developers of LEED-certified buildings through the Income Tax Act. Developers can claim up to 100% depreciation on the cost of green building assets, such as solar panels, rainwater harvesting systems and waste management systems.
- **Loans** - The Indian government provides low-interest loans through the Indian Renewable Energy Development Agency (IREDA) for building projects with green certifications.
- **Public procurement -** The Indian government has implemented a policy that requires all government buildings to be certified green and meet green building standards.
- **State-level incentives** - Many states in India have their own policies and plans to promote green building certification, such as providing subsidies and tax exemptions to promote energy-efficient buildings and renewable energy projects.
- **Fast-track approvals** - Buildings that are certified green are eligible for incentives such as fast-track approvals, expedited inspections and reduced building fees.
- **Promotion of renewable energy** - The government also provides subsidies and tax benefits to promote renewable energy in the country; this can indirectly promote LEED-certified buildings.

EUROPEAN UNION

The European Energy Performance of Buildings Directive introduced an energy performance label for buildings from "A" to "G," with "A" being the most energy efficient. Many European Member Countries adopted a decree requiring office buildings to have an energy performance label of "C" or higher by 2023 and an "A" label by 2030. An office building falling short of the requirements can no longer be used, sold, or leased, effectively making it a stranded asset.

Energy Performance Certificates (EPC) provide information to consumers on buildings they plan to purchase or rent. They include an energy performance rating and recommendations for cost-effective improvements. Certificates must be included in all advertisements in commercial media when a building is put up for sale or rent.

[13] Tejal Chottai, Green Building Council of India, "Government incentives for green building projects in India" (2023) https://www.gbci.org/government-incentives-green-building-projects-india

An EPC typically has two ratings: an energy label, which rates the primary energy consumption of the building, and a climate label, which rates the amount of greenhouse gases emitted. Both are given one of the seven classifications from A to G as shown in the Figure 3.

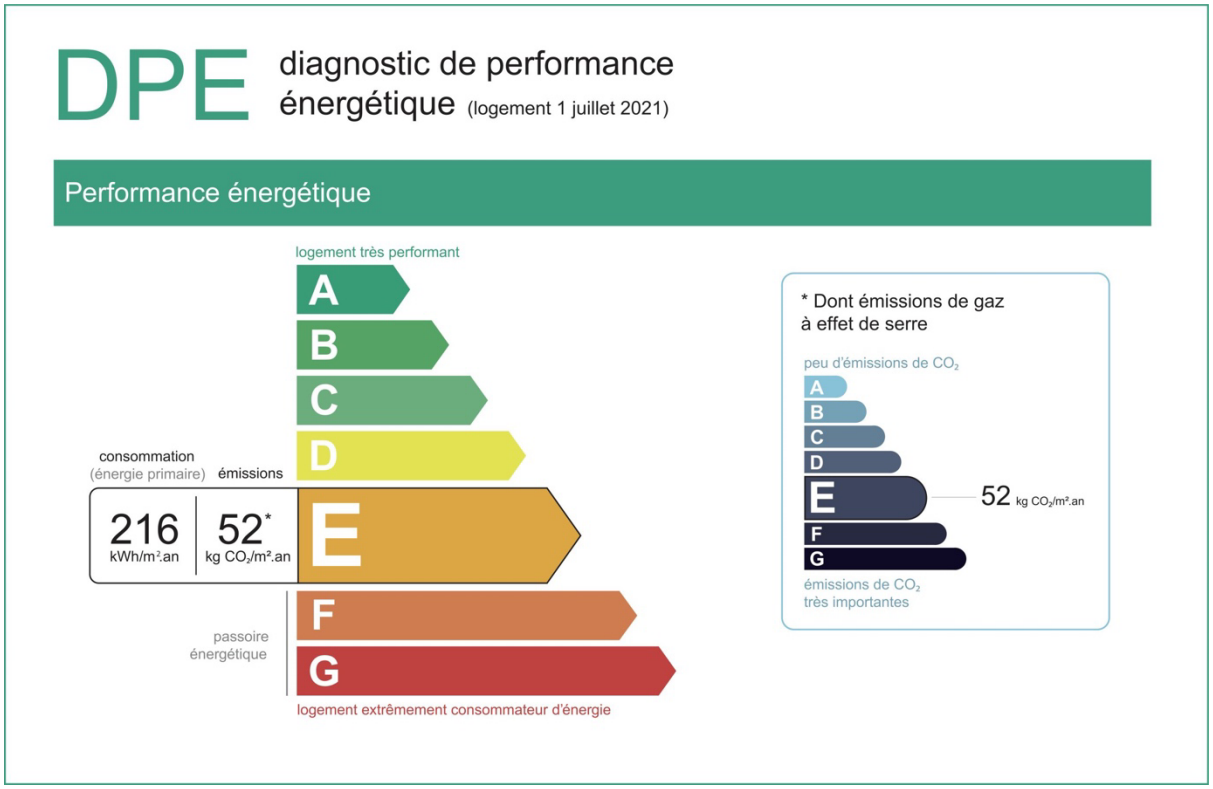


Figure 3: Energy Performance Certificate – energy and climate ratings implemented in France.[14]

Figure 4 provides an overview of the number of green buildings in various countries, as reported by the Leadership in Energy and Environmental Design (LEED) rating system. LEED is a widely recognized certification system for sustainable and green building practices. The United States leads the pack with a substantial number of green buildings, reflecting the country's strong commitment to sustainability and environmentally friendly construction practices. China follows as the second-largest contributor to green building projects; Canada ranks third on the list. While India emerges as a prominent player in the global green building landscape, The United Arab Emirates (UAE) rounds off the top five.

[14] French Property Need-to-Know: Energy Performance Certificates, French Entrée, (2022) https://www.frenchentree.com/french-property/selling-homes/french-property-need-to-know-energy-performance-certificates/

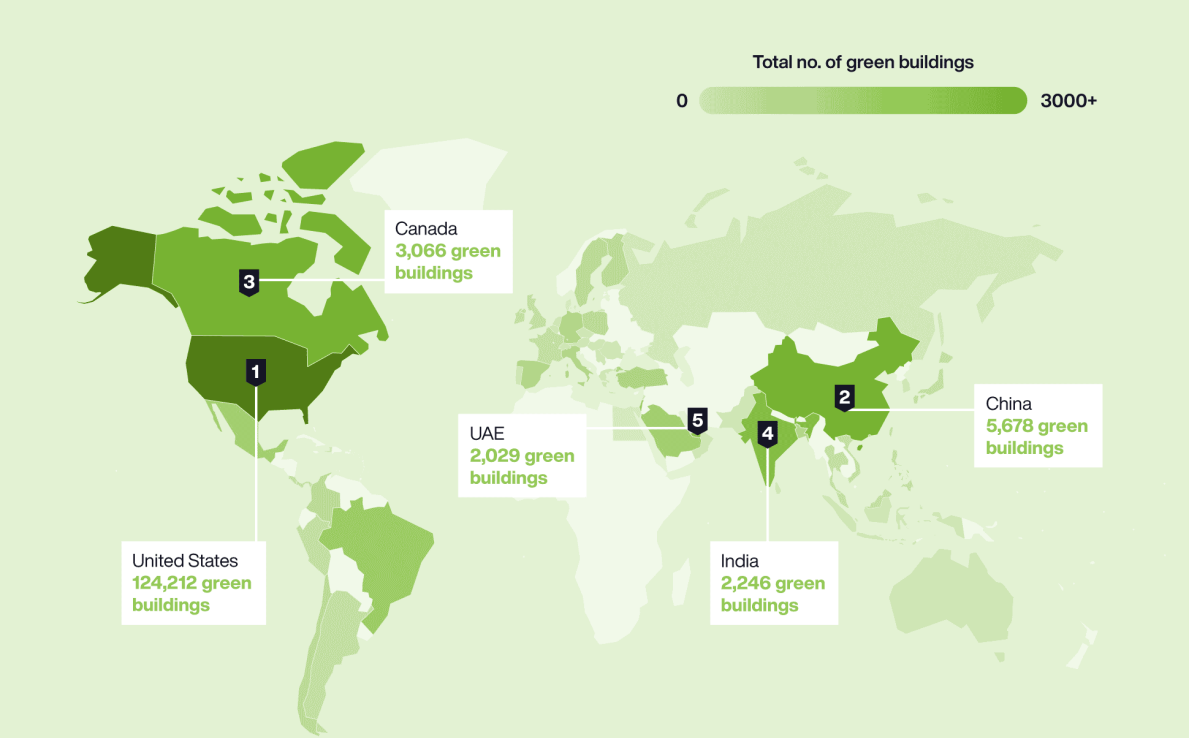


Figure 4: Countries with most green buildings in the world (Source: Uswitch[15])

BARRIERS AND CHALLENGES TO ADOPTION OF GREEN BUILDINGS

The primary challenge that stands out when it comes to scaling the adoption of green buildings is the high upfront cost of implementation. This high cost not only raises rental expenses but also creates hurdles in attracting both investors and tenants, making green buildings less accessible to individuals with limited capital.

While green buildings offer positive environmental benefits and play a crucial role in reducing greenhouse gas emissions, there are several challenges hindering their widespread adoption of green buildings.

Key barriers to financing green buildings include:

1. **Split Incentives** - Within the building market, an issue arises where different parties have conflicting incentives. For instance, developers may be hesitant to invest in green building design due to upfront costs, while the cost savings will primarily benefit future owners.
2. **Developer Hesitance** - Developers may be reluctant to absorb the additional upfront costs associated with green building design, especially when the financial benefits accrue over extended periods, potentially beyond their ownership.

[15] Global Green Building Leaders, Uswitch https://www.uswitch.com/gas-electricity/global-green-building-leaders/

3. **Building Longevity vs. Investment Holding Periods** - Mismatches often occur between the longevity of green buildings and the relatively short holding periods for real estate assets in investment portfolios.
4. **Minimal Landlord Incentives** - In cases where tenants are responsible for utility bills, landlords may have limited incentives to invest in energy efficient equipment.
5. **Subsidized or Government-Controlled Energy Prices** - Subsidized or government-controlled energy prices can affect the motivation to invest in energy efficiency.

In addition, lack of awareness and education is also a key challenge. There is a substantial need for increased awareness, information dissemination, and education regarding the benefits of green building, both for individual well-being and broader public benefits. Besides, limited access to technical resources also hinders the adoption. Limited access to design, construction materials, and skilled workers also impede the construction of green buildings. While in case of Pakistan, the fundamental challenge is the weak enforcement of building codes. The absence of comprehensive building codes, guidelines, standards, and policies that promote and incentivize green building practices can pose a significant challenge to their widespread adoption.

POLICY INSTRUMENTS TO PROMOTE GREEN BUILDINGS

To promote the widespread adoption of green building practices, governments and regulatory bodies worldwide have implemented a diverse array of policies and incentives. These initiatives serve as critical drivers for the integration of sustainable construction methods and the reduction of environmental impacts in the building sector.

1. Codes and Standards

One of the fundamental pillars of green building promotion is the development and enforcement of building codes and standards that prioritize energy efficiency, water conservation, and environmental responsibility. These codes set the benchmark for sustainable construction practices and ensure compliance with eco-friendly building materials and technologies.

2. Tax Incentives

Tax incentives are powerful tools to encourage green building investments. Leading countries in the green building space offer many tax credits or deductions to individuals or businesses that undertake green building projects. These incentives not only reduce the financial burden of green construction but also stimulate economic activity in the sustainable building sector.

3. Grants and Subsidies

Grants and subsidies are another vital policy instrument. They provide financial support to offset the additional or premium costs associated with green building practices. These incentives are particularly valuable for individuals and organizations looking to invest in environmentally responsible construction.

4. Loans

Accessible loans with favorable terms can significantly impact green building adoption. Low-interest or green-focused loans make it more affordable for builders and homeowners to invest in sustainable construction methods and energy-efficient technologies.

5. Public Investment and Procurement

Governments can lead by example through public investment in green building projects and sustainable infrastructure. Additionally, public procurement policies that prioritize environmentally friendly construction materials and practices can drive demand for green building products and services.

Barriers	Policy Instruments	Actors				
		1	2	3	4	5
Definition of Green Buildings	#Adoption of Green Building Labels	√	√	√	√	√
Funding Issues	#Grants and Loans	√	√	√		
Lack of Incentives	#Density Bonus	√	√			
	#Tax Credits	√	√	√		
	#Expedited Permit Process	√	√			
	*Eco Tax		√	√	√	
Split Incentives and Appropriability	#Regulation on Property Valuation	√	√	√	√	
	*Tenancy Law		√	√		
Lack of Knowledge and Awareness	#Performance Rating Disclosure System				√	
	#Mandatory Standards for Government Buildings	√	√	√	√	
	#Free Technical Advices	√	√	√		
	#Information on the Internet	√	√	√	√	√
	#Education and Training Programs					√
	*Green Building Audits		√	√		
	*Desktop Advices/Assistance		√	√		

†Targeted actors: 1. Developers, 2. Developer-Owners, 3. Individual Owners, 4. Tenant Users and 5. Contractors
#Policies for Green Building

Table 2: barriers and policy instruments to promote green buildings by engaging key stakeholders.[16]

Table 2 provides a snapshot of key barriers and corresponding policy instruments with indication of key actors involved in green building practices.

COST OF BUILDING GREEN

The cost of building green is not a one-size-fits-all proposition but varies significantly based on numerous factors, including local climatic conditions, the availability and cost of eco-friendly building materials, the accessibility of energy- and water-efficient equipment, and the presence of technical expertise in green construction. Consequently, determining an exact cost for green building across different countries can be challenging due to these varying influences[17].

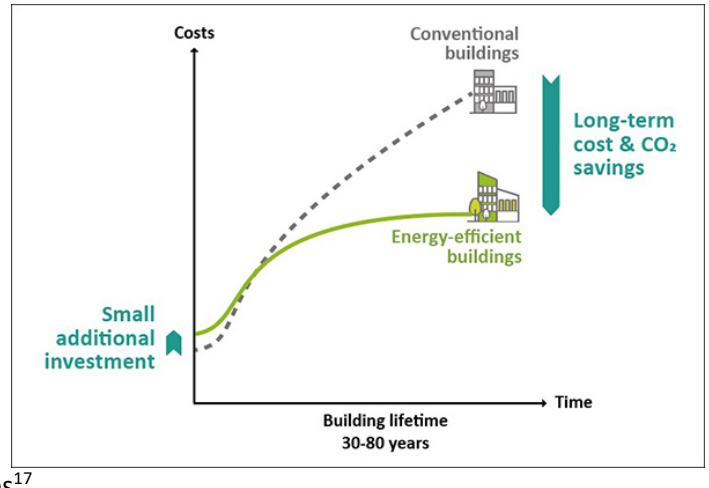


Figure 5: Cost of Green Buildings over Time [18]

[16] A Review on Barriers, Policies and Governance for Green Buildings and Sustainable Properties https://www.irbnet.de/daten/iconda/CIB_DC26611.pdf

[17] IFC - Green Buildings | A Finance and Policy Blueprint

[18] Programme for Energy Efficiency in Buildings (PEEB), Green Buildings for Economy and Climate, https://www.peeb.build

Numerous studies suggest that green building projects typically incur an additional cost ranging from 5% to 15% when compared to conventional construction methods. However, what makes green building particularly attractive is the relatively short payback period, usually falling within the range of 3 to 5 years[19]. This means that the upfront investment in green building practices is often recouped through operational cost savings and efficiency gains within a relatively short timeframe.

Due to the limited availability of comprehensive data, determining the precise cost premium associated with green building in Pakistan remains a challenge. The cost dynamics of green building can vary significantly based on local conditions, materials, and practices, making it essential to gather specific and regionally relevant data for accurate assessments. It is reasonable to assume that the additional investment or premium cost associated with building green can pose a primary barrier to the widespread adoption of green buildings in developing countries, particularly in the case of Pakistan.

However, while specific cost premiums may not be readily available, it's important to acknowledge the broader trends and principles associated with green building. Generally, green building practices may involve a high initial upfront investment compared to conventional construction methods, though lower operating costs over the period of building reduces the total cost of ownership as presented in the Figure 5.

Certified green buildings offer a range of tangible benefits, including lowered operating expenses and enhanced resource efficiency. These benefits manifest in reduced utility bills, decreased waste output, and lower maintenance costs. In terms of energy and water consumption, green buildings can achieve savings exceeding 20% compared to conventional buildings. This translates to substantial savings for green homeowners, typically ranging from 15% to 20% on their utility bills. In the commercial sector, green buildings have demonstrated remarkable cost-effectiveness, with operating expenses falling between 18% and 37% lower than those of traditional buildings.

3: GOVERNANCE STRUCTURE AND BUILDING REGULATIONS IN PAKISTAN

The governance structure and building regulations in Pakistan are multifaceted, involving multiple layers of stakeholders at the national, provincial and district levels. A sporadic regulatory framework of energy efficient buildings in Pakistan is in place, though it is not uniform across different parts of the country. Therefore, the enforcement and compliance to building regulations vary significantly across the country and there are serious governance issues in the construction industry in Pakistan.

NATIONAL LEVEL OVERSIGHT ON BUILDING RELATED POLICY AND REGULATIONS

[19] Cost of Green Building in India: What is the Payback Period?https://www.inhabit.co.in/blogs/post/Cost-of-Green-Building-in-India_What-is-the-Payback-Period

These are the key stakeholders at National Level in Pakistan and play a significant role in policy formulation and the establishment of regulatory frameworks, although they typically do not directly oversee the enforcement of these standards at the operational level.

1. **Ministry of Housing and Works** - At the national level, the Ministry of Housing and Works plays a pivotal role in setting the governing framework for buildings and construction, particularly for federal agencies. This ministry provides policy guidance and regulatory oversight to promote safe and sustainable building practices for Federal Government owned buildings.

2. **Pakistan Engineering Council (PEC)** - The enactment of a building code comes under the purview of PEC (Act of 1975-Section 25). Thus, PEC is responsible for developing the Building Codes of Pakistan and monitoring construction and engineering works. PEC also plays a critical role in establishing construction standards for engineering and construction firms in Pakistan.

3. **Pakistan Council of Architects and Town Planners (PCATP) -** PCATP is instrumental in regulating and accrediting professionals in the fields of architecture and town planning. Their involvement ensures that building designs adhere to best practices in urban planning and architecture.

4. **National Energy Efficiency and Conservation Authority (NEECA)**: NEECA operates under the Ministry of Energy and is tasked with developing Energy Building Codes to promote energy-efficient construction practices. This authority focuses on achieving energy efficiency goals in the construction sector.

PROVINCIAL AND DISTRICT LEVEL GOVERNANCE AND IMPLEMENTATION

In Pakistan, the building regulations for implementation involve various government entities and building authorities at both the provincial and local levels. These entities have distinct roles and responsibilities pertaining to construction standards and practices, yet their effectiveness in achieving their objectives has faced challenges.

Each province has its own relevant Department of Urban Development and Housing which are tasked with overseeing urban development and housing initiatives within their respective provinces, including the formulation and implementation of building regulations. While Building Control Authorities at the provincial level regulate construction practices, and issue building permits down to the district level and are responsible for ensuring compliance with local building codes.

Moreover, in major urban centers such as Karachi, Islamabad, and Lahore, Development Authorities are responsible for developing and enforcing their own local building by-laws. District Building Control Authorities also play a role in scrutinizing building designs, conducting on-site inspections of construction projects, and issuing occupancy permits. Then there are Municipal and Town corporations with jurisdiction over specific areas and enforce their own building by-laws and regulations. Additionally, there are Cantonment Areas, which maintain their own governance structures and building by-laws, operating independently from municipal regulations.

Despite this multi-layered framework and institutions, the effectiveness of these agencies in delivering their objectives has faced challenges, raising questions about their ability to consistently enforce building regulations and ensure compliance with building codes across the country.

COMPLIANCE AND IMPLEMENTATION OF BUILDING CODES

In Pakistan, compliance with building codes is primarily the responsibility of design professionals, contractors while provincial and building authority officials are responsible for enforcement of the building codes. However, it's important to note that the enforcement framework is still evolving and significantly vary in maturity across different cities.

Compliance mechanisms typically involve verifying proposed designs in alignment with local building by-laws. In some major cities like Karachi, Islamabad and Lahore; there is a growing trend to vet structural designs, although this practice is not yet common in all urban areas.

For government-owned buildings, construction is supervised either by nominated consultants or by the government organization itself, ensuring adherence to approved designs and specifications. While building designs often align with the Building Codes of Pakistan, construction quality may vary and may not always conform to standard specifications[20].

BUILDING ENERGY CODES IN PAKISTAN

PAKISTAN BUILDING ENERGY CODE 1990

The establishment of building energy codes in Pakistan falls within the jurisdiction of the Pakistan Engineering Council (PEC), as outlined in the PEC Act of 1975 (Section 25). Any code pertaining to building construction undergoes review and approval by the PEC. Earlier, energy conservation efforts in Pakistan have been undertaken by the National Energy Conservation Centre (ENERCON), established as part of a USAID project in 1985 under the Ministry of Planning & Development.

Pakistan's first-ever Energy Building Code was introduced in 1990. ENERCON, in collaboration with the Environment and Urban Affairs Division, developed this Building Energy Code for Pakistan as an addendum to the Building Code of Pakistan 1986 (BCP 1987), which served as Pakistan's First National Building Code. It is worth noting that this code operated as an advisory guideline and was not made mandatory.

Over the years, the administrative oversight of ENERCON has shifted. In 1993, it was transferred to the Ministry of Water and Power and subsequently to the Ministry of Environment in 1996. In 1997, ENERCON became an attached department of the Ministry of Environment but was later transferred back to the Ministry of Water and Power in 2011.

[20] World Housing Encyclopedia, Housing Report, Reinforced concrete buildings in Pakistan https://www.world-housing.net/WHEReports/wh100184.pdf

In 2007, Pakistan revised and published its second Building Code of Pakistan (BCP 2007), prompted by the devastating earthquake in 2005, with a focus on strengthening seismic provisions. BCP 2007 established minimum regulations for earthquake considerations in building systems. Notably, BCP 2007 draws heavily from the Uniform Building Code (UBC) 1997, with indigenous adjustments primarily in seismic zonation. Buildings designed under BCP 2007 adhere to design specifications closely aligned with UBC 97. Material specifications are referenced to ASTM specifications, governing the quality assurance of materials such as steel, concrete, and bricks.

PAKISTAN BUILDING ENERGY CODE 2011 (ENERGY PROVISIONS 2011)

In 2011, ENERCON, in collaboration with the Pakistan Engineering Council (PEC), initiated the development of a new Building Energy Code for Pakistan, referred to as Energy Provisions-2011. This code received official endorsement from PEC and was officially introduced in 2013. Energy Provisions-2011 initially featured a single climate zone for building envelopes, primarily based on ASHRAE Standard 90.1 - 2013, with Pakistan being designated as Climate Zone 1, centered around Karachi[21]. However, recognizing the country's diverse climate conditions, the code did not serve the purpose in terms of climate zoning to address thermal performance across various part of the country.

Energy Provisions-2011 established minimum energy efficiency requirements and was tailored to guide the design and construction of new high-end residential and commercial buildings, as well as specific building clusters meeting defined criteria. These criteria included a total connected load of 100 kW or more, a contract demand of 125 kVA or greater, a conditioned area exceeding 900 m^3, or unconditioned buildings with a covered area exceeding 1200 m^2. Consequently, Energy Provisions-2011 had a limited scope, primarily targeting larger institutional, commercial, and industrial buildings.

In 2016, ENERCON underwent a transformation, evolving into the National Energy Efficiency and Conservation Authority (NEECA) through NEECA Act 2016, functioning as an attached department within the Ministry of Water and Power. It is important to note that while the first energy conservation building code for Pakistan was introduced by ENERCON in 1990, its practical implementation remained voluntary. Following the 18th amendment in Pakistan's constitution, NEECA's provincial responsibilities were transferred to provincial energy departments.

NEECA ENERGY CONSERVATION BUILDING CODE (ECBC) 2023

[21] A Comparative Analysis of Energy Provisions of Pakistan Building Code with Indian and USA Building Energy Codes. Available from: https://www.researchgate.net/publication/327264251_A_Comparative_Analysis_of_Energy_Provisions_of_Pakistan_Building_Code_with_Indian_and_USA_Building_Energy_Codes[accessed August 28 2023].

In 2023, NEECA introduced the Energy Conservation Building Code 2023 (ECBC-2023), representing a revised and updated version of the Building Code of Pakistan (Energy Provisions-2011). ECBC-2023 is designed to incorporate state-of-the-art technologies, facilitating the implementation of energy efficiency and conservation measures. This updated code primarily targets high-end domestic and commercial consumers, aiming to conserve energy while maintaining public safety.

ECBC-2023 includes various aspects, including building envelope optimization, passive building design principles, building insulation, retrofitting of existing buildings for enhanced energy efficiency, energy analysis through monitoring devices, exploration of renewable and geothermal energy integration within buildings, and the introduction of energy management systems.

The scope of this code has been expanded and applies to buildings and building clusters that meet specific criteria, including a total connected load of 50 kW or greater, a contract demand of 75 kVA or greater, a conditioned area of 200 m^2 or more, or unconditioned buildings with a covered area exceeding 300 m^2. It extends its coverage to fully detached, semi-detached, and un-detached residential as well as commercial buildings.

Local authorities play a significant role in the implementation of ECBC-2023, particularly as part of the building construction permit application and approval process. Additionally, the code is designed to undergo periodic revisions every three years to ensure its continued relevance and effectiveness. Its comprehensive coverage includes energy-efficient and low-emission construction materials, passive building design principles, energy appliance monitoring devices, electric vehicle charging infrastructure, energy management systems, building insulation, and the integration of renewable and geothermal energy solutions.

PUNJAB BUILDING ENERGY CONSERVATION BUILDING CODE 2017

As per the provisions of the NEECA Act 2016, provinces were granted the authority to amend, enhance, or develop their own Building Energy Codes tailored to local climatic conditions. Punjab took the lead in establishing the Punjab Energy Efficiency and Conservation Agency (PEECA) in 2016, following the enactment of the National Energy Efficiency and Conservation Act-2016. All provinces were encouraged to establish energy efficiency and conservation bodies. PEECA commenced work on reviewing and modifying the code originally developed by ENERCON/NEECA, known as the Pakistan Building Code (Energy Provisions-2011). Punjab introduced Punjab Building Energy Conservaiton Building Code 2017. In accordance with Energy Provisions – 2011), this code was applicable to buildings and building clusters that have a total connected load of 100 kW or greater, or a contract demand of 125 kVA or greater, or a conditioned area of 900 m^2 or greater, or an unconditioned building of covered area of 1,200 m^2 or more.

PAKISTAN GREEN BUILDING GUIDELINES 2016

Pakistan Green Building Guidelines were established by Pakistan Green Building Council (PGBC). This serves as a reference guide of building design and construction in Pakistan. PGBC is a non-profit organization dedicated to fostering a sustainable future in Pakistan through the promotion of

resource-efficient green buildings and communities, emphasizing cost savings, energy efficiency, water conservation, and responsible use of natural resources. Pakistan GBC is currently a prospective member of the World Green Building Council, it serves as the exclusive representative of the World GBC within Pakistan.

Pakistan Green Building Council PGBC has developed its own rating system based on Pakistan-specific Green Building Guidelines. The first version of SEED-Sustainability in Energy and Environmental Development is published in Oct 2016 by PGBC. SEED is aims to address sustainable and socially responsible thinking about how buildings and communities are planned, constructed, maintained, and operated There are four tiers in certification depending on the points achieved by a building. The certifications are silver, gold, platinum, and titanium; the last one being the highest point scored.

PEC GREEN BUILDING CODE OF PAKISTAN 2023

Recently Pakistan Engineering Council (PEC) released the Green Building Code of Pakistan in May 2023 based on the 2021 edition of the International Green Construction Code (IgCC) as reported by International Code Council (ICC)[22] In 2016, EU SWITCH-Asia in collaboration with the Ministry of Climate Change, UN Environment, and UN Habitat-Pakistan launched the Sustainable Consumption and Production (SCP) Programme in Pakistan, focused on the SDG-12 and provided guidelines for the transformation of the conventional built practices into a green built environment across Pakistan.

As part of this program, EU SWITCH-Asia SCP Programme, UN Environment, and UN-Habitat successfully developed Policy Guidelines - Green Building Code for Pakistan, in line with the commitment of the Government to pursue climate resilient and green development initiatives.

The Ministry of Climate Change along with relevant stakeholders including Pakistan Engineering Council is working on the development of the Green Building Code for greening the Building Construction Sector in Pakistan[23].

ASSESSMENT OF BUILDING GROUPS AND TYPES IN PAKISTAN

Access to comprehensive data on building stock presents a considerable challenge in Pakistan, primarily due to the fragmented nature of the construction industry. With numerous stakeholders at the federal, provincial, and district levels, a centralized repository of information is challenging to establish. While the Pakistan Bureau of Statistics is a key resource for such data, it currently offers limited information without a clear breakdown of building types, such as residential, commercial, office spaces, or other categories.

[22] Pakistan Engineering Council Releases Green Building Code Based on the International Codes (ICC 2023) (https://www.iccsafe.org/about/periodicals-and-newsroom/pakistan-engineering-council-releases-green-building-code-based-on-the-international

[23] EU SWITCH Asia Programme

The majority of the building stock consists of non-engineered structures. According to the Pakistan Bureau of Statistics, housing in Pakistan falls into three broad categories: "pukka" houses, constructed using durable materials like stone, brick, cement, concrete, or timber; "kuchha" houses, constructed with less durable materials like mud, bamboo, reeds, or thatch, constituting approximately 35% of the housing stock; and "semi-pukka" houses (11%), representing a hybrid between the two. Among these, the higher-quality "pukka" houses make up approximately 54% of the total housing stock.

Building Type Distribution in Pakistan					
Region	Adobe Structures (%)	Stone Masonry Structures (%)	Concrete Block Masonry Structures (%)	Brick Masonry Structures (%)	Wooden Structures (%)
Pakistan (total)	36.0	24.0	13.1	21.4	5.4
Sindh	36.6	1.3	20.9	25.5	15.7
Punjab	31.4	34.8	11.2	21.9	0.7
NWFP	39.8	32.5	9.1	16.4	2.3
Balochistan	73.0	3.9	5.7	5.2	12.2
FATA	59.2	32.3	2.9	3.4	2.2

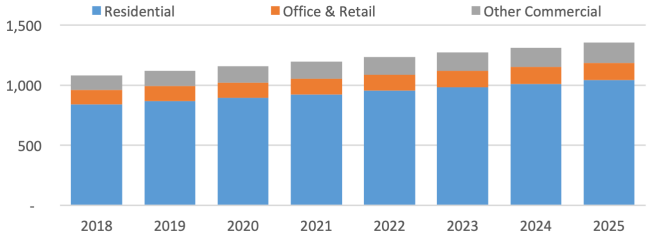
Table 3: Building Stock Distribution by type of Construction.[24]

The building stock in the Pakistan can be classified into five categories depending upon the material used in walls and roofs. Regarding building types, Pakistan features diverse construction typologies, including brick masonry, block masonry, stone masonry, adobe masonry, reinforced concrete structures, and wooden and timber constructions. The distribution of buildings in Pakistan encompasses adobe structures (36%), stone masonry (24%), concrete block masonry (21%), brick masonry (21.4%), and wooden and timber constructions (5.4%) as highlighted in Table 3. Reinforced concrete (RC) frame structures are predominantly found in urban areas and constitute a relatively small percentage of the overall building stock in Pakistan. Due to their limited prevalence compared to other construction types, RC structures are not separately categorized in the building type distribution. Instead, they are included within the broader classification of brick masonry structures in Table 3.

According to the International Finance Corporation, the Pakistani building market consists of 79% residential buildings and 21% commercial buildings as highlighted in Figure 6. In terms of area, residential spaces encompass around 1,000 million square meters, while office, retail, and other commercial spaces occupy over 300 million square meters in Pakistan. The total real estate market size is projected to exceed $290 billion by 2025, with the commercial market accounting for $54 million and the residential market exceeding $234 million. However, the green building market's share

[24] Tariq Maqsood and J. Schwarz, “Analysis of Building Damage during the 8 October 2005 Earthquake in Pakistan” (2008), Seismological Research Letters 79(2):163-177

remains relatively small, at less than $10 billion, and its growth is expected to be gradual in the coming years.



Market through 2025	Total market	Green market
Commercial	USD 53.45 B	USD 1.55 B
Residential	USD 232.6 B	USD 9.84 B
Total Residential Units	3,100,000	140,000

Figure 6: Composition of Building Market Space in in Pakistan by Commercial, residential and office space. (Source: International Finance Cooperation IFC)

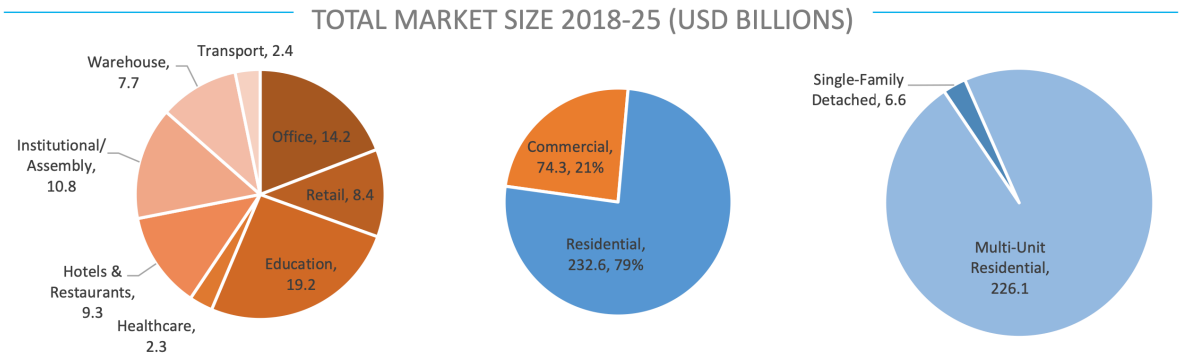


Figure 7: Total Market Size of Buildings in Pakistan (Source: International Finance Cooperation IFC)

Table 5 presents the description of the main load-bearing elements in different building types in Pakistan. Primary elements are the vertical load-bearing members. Secondary elements are the horizontal load-bearing members, while tertiary elements are the floors and roofs.

HOUSING UNITS BY CONSTRUCTION MATERIAL

(In percent)

Administrative Units		Material used in Outer Walls				Material Used in Roofs			
		Baked Bricks/n-Baked Brick Blocks/Stone	Earth Bound	Wood/ Banboo	Others	RCC/RBC	Cement/ Iron Sheet	Wood/ Bamboo	Others
Pakistan		58.46	34.48	5.42	1.64	21.39	13.07	57.35	8.18
	Rural	45.96	44.69	7.20	2.14	10.43	10.05	69.76	9.76
	Urban	85.76	12.16	1.53	0.54	45.35	19.69	30.23	4.74

Table 4: Housing Units in Pakistan by Construction Material (Source: Pakistan Bureau of Statistics)

Description of Building Types in Pakistan			
Type	**Elements**		**Description**
Adobe Structure	Primary	Adobe walls	Low-strength adobe walls are used, which normally don't have any vertical wooden post.
	Secondary	Adobe walls	No additional system such as crown beam or pilasters is provided to restrain the out-of-plane failure.
	Tertiary	Wooden and mud roof	Wooden logs (beams) with heavy mud roof and straw are used as roof.
Stone Masonry Structure	Primary	Simple or rubble stone masonry walls	Simple or rubble stone masonry walls are normally used in lean cement-sand mortar, often with mud mortar and sometimes even without any mortar.
	Secondary	Simple or rubble stone masonry walls & wooden vertical post, if provided	The walls don't have a proper connection among the stone layers. The walls are normally without any vertical post but occasionally wooden posts are also provided.
	Tertiary	Wooden and mud roof	Wooden logs (beams) with heavy mud roof and straw are used as roof.
Concrete Block Masonry Structure	Primary	Concrete block masonry walls	Low to medium quality concrete blocks with compressive strength of about 5–6 MPa are used. Generally cement-sand mortar of 1:8 ratio is used for this type of building. The dimension of the block is 300 mm x 150 mm x 150 mm.
	Secondary	Simple or rubble stone masonry walls and wooden vertical post, if provided	Concrete block masonry walls resist the lateral loads. Lintel beams are provided over the openings of doors and windows, but generally they do not run continuously throughout the perimeter. Ring or connecting beams between roof and masonry walls are rarely provided. In some constructions, concrete or wooden posts are provided for lateral load resistance.
	Tertiary	Cement or iron sheet roof	The roof slab is made of cement or iron sheets that normally are light-weight. Sometimes a 150-mm thick reinforced concrete slab is also used.
Brick Masonry Structure	Primary	Solid burnt brick walls	Clay brick with compressive strength of about 8 MPa are used in walls. Generally cement-sand mortar of 1:6 ratio is used for this type of building. The dimension of the brick is 230 mm x 115 mm x 75 mm.
	Secondary	Solid burnt brick walls with lintel beams. Ring beams & vertical concrete or wooden post, if provided.	Solid burnt brick walls resist the lateral loads. Lintel beams are provided over the openings of doors and windows, but generally they do not run continuously throughout the perimeter. Ring or connecting beams between roof and masonry walls are rarely provided. In some constructions, concrete or wooden posts are provided for lateral load resistance.
	Tertiary	Reinforced concrete roof slab	The roof slab is made of reinforced concrete having compressive strength of 21 MPa and 150-mm thickness. The mixed ratio of concrete is 1:2:4.
Timber Structure	Primary	Timber frame: wooden columns & beams with infills	Timber frames, placed in longitudinal and transverse directions, are filled with masonry walls. Most of the buildings are rectangular in shape with few openings.
	Secondary	Timber frame: wooden columns & beams with infills	Timber frames, placed in longitudinal and transverse directions, are filled with masonry walls.
	Tertiary	Wooden and mud roof	The floor structure is made of timber planks. The roofing material is usually light when it is made from galvanized iron sheets. Timber planks with heavy mud roof and straw are also used as a roof.

Table 5: Description of the main load-bearing elements in different building types in Pakistan. [25]

[25] Tariq Maqsood and J. Schwarz, "Analysis of Building Damage during the 8 October 2005 Earthquake in Pakistan" (2008), Seismological Research Letters 79(2):163-177

4: GREEN BUILDING PRACTICES IN PAKISTAN

CURRENT PRACTICES IN CONSTRUCTING BUILDINGS IN PAKISTAN.

As emphasized in the previous section, the adoption and enforcement of Building Energy Codes in Pakistan remain non-mandatory and face significant challenges in garnering support from local governments. To date, none of the local councils have officially embraced the adoption of these Building Energy Codes in true sense, which demonstrates the presence of legal, regulatory, technical, institutional, and financial obstacles in construction practices in the country.

In urban centers, there exists a degree of regulatory compliance and enforcement that leads to a notably higher quality of construction compared to other parts of the country. However, the construction practices in rural areas raise substantial concerns. The construction in these areas is often unplanned, illegal, unsafe, and unhygienic.

One of the critical concerns related to such construction practices in Pakistan is their vulnerability to natural disasters, particularly earthquakes and floods. Many buildings in rural areas lack the structural integrity necessary to withstand seismic activity and other natural calamities. This vulnerability leads to tragic consequences, including the loss of human lives, livestock, and valuable resources.

PIONEERING GREEN BUILDING LEED CERTIFICATIONS IN PAKISTAN

The total area covered by Green Buildings as referred as LEED-certified buildings in Pakistan currently stands at an impressive 13.25 million square feet[26]. This encouraging trend in LEED certification becomes evident when comparing the present scenario to that of 2014 when there were merely 10 LEED-certified buildings.[27] Currently, Pakistan has over 60 such certified structures, highlighting a significant upsurge in the adoption of sustainable and environmentally responsible building practices across the country.

The Leadership in Energy and Environmental Design (LEED) is a certification program primarily designed for new commercial building projects, utilizing a point-based system to assess and rate the environmental sustainability of a structure.

The LEED rating is determined by the number of points a building accumulates, reflecting its level of "greenness" in terms of energy efficiency, water conservation, air quality, and the use of environmentally friendly building materials, both during construction and throughout its operational life. LEED-certified buildings are categorized based on their credit points: 40-49 credits for LEED-certified, 50-59 for LEED Silver, 60-79 for LEED Gold, and 80 or more credits earn the prestigious LEED

[26] Green Building Information Gateway (GBIW), https://www.gbig.org/places/809

[27] Green Buildings Market Intelligence Pakistan Country Profile, https://edgebuildings.com/wp-content/uploads/2022/04/Pakistan-Green-Building-Market-Intelligence-EXPORT.pdf

Platinum designation[28]. Projects seeking LEED certification earn points in various categories, including energy efficiency and indoor air quality.

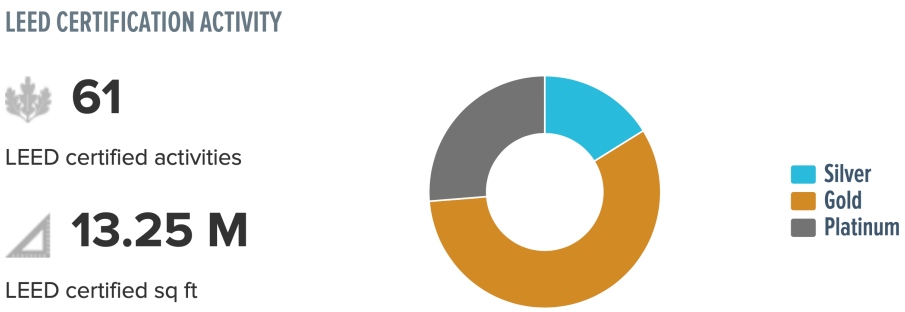


Figure 8: LEED Certification Activity Snapshot in Pakistan

According to the Green Building Information Gateway (GBIG), Pakistan boasts over 60 LEED-certified green buildings recognized by the US Green Building Council, with an additional 2 buildings receiving the Achiever Award. Notably, more than a quarter (26%) of these certified buildings have achieved the highest Platinum rating, followed by Gold-rated buildings comprising 57%, and Silver-rated structures making up 16% of the total. This indicates a significant presence of green building projects in Pakistan that prioritize sustainability and environmental performance across various categories.

5. BUILDING ENVELOPE AND BUILDING PERFORMANCE

A building envelope serves as a protective shield that separates the interior of a building from the external environment, including its walls, roofs, fenestration (doors and windows), and insulation. Its primary function is to ensure the comfort and well-being of occupants by regulating the transfer of heat, air, and moisture between the inside and outside of the building.

What sets energy-efficient building envelopes apart is their ability to do more than just create a barrier; they actively respond to the surrounding environment, leading to significant reductions in energy consumption. These envelopes are designed with advanced features like high-quality thermal insulation, effective vapor barriers, superior seals for windows and doors, and mechanisms to control airflow, thereby minimizing the infiltration of outdoor air. These elements work in unison to maintain a comfortable and energy-efficient indoor environment.

Climate type	**Design strategies for energy-efficient facades**
Heating-dominated	The building envelope receives solar heating.

[28] The British Council Lahore's Green & Leed Certified Library Building, https://opamss.org.sv/wp-content/uploads/2020/03/BRITISH-COUNCIL-LAHORE-GREEN-AND-LEED-CERTIFIES-LIBRARY-BUILDING.pdf

	Walls can be used as thermal masses for thermal storage. Better insulation to minimize thermal losses. Natural daylight is used. Facades have increased glazing areas to allow for natural light; light shelves that redirect light into interior spaces are used.
Cooling-dominated	Appropriate shading techniques can be employed to protect from direct solar gain. Use insulation to reduce solar heat gain. Design to facilitate natural ventilation (wing walls). Natural daylight should be used in such a way that solar heat gain is minimized.
Mixed climates	Use shading devices to protect facade from direct solar radiation during warm days. Use passive solar design for heating during cold seasons. Use natural daylight and with increased glazed areas of walls with shading devices.

Table 6: Climate-specific design of energy efficient envelopes.[29]

A building envelope acts as a barrier that separates the interior from the external world. It's similar to the shell of a building, offering defense against the elements outside.

During the winter, the building envelope plays a crucial role in preventing the escape of indoor heat to the cold outdoors. Conversely, in the scorching summer months, it keeps the cool air inside while fending off the sweltering heat.[30]

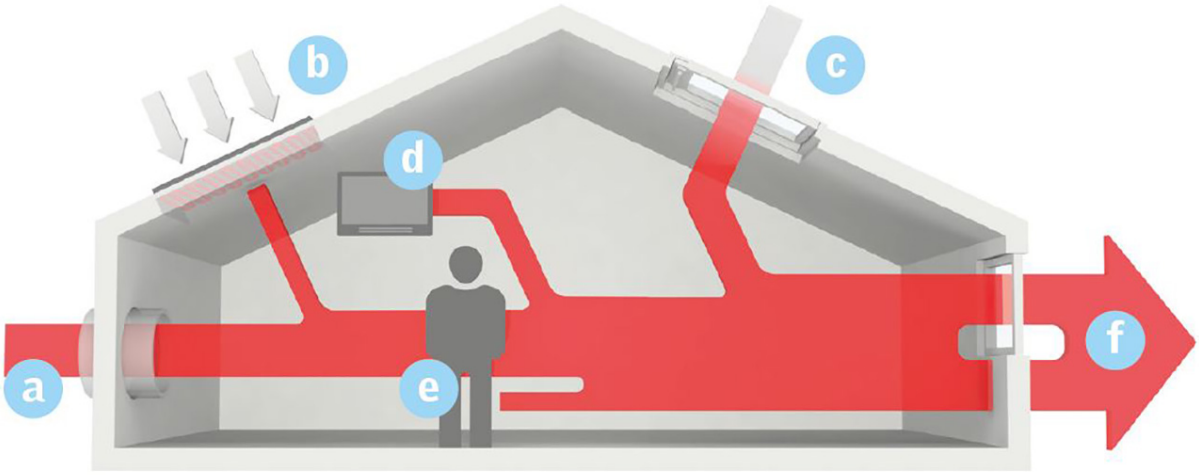
In a country like Pakistan, where the demand for cooling is high across much of the nation, the design of the building envelope must be carefully orchestrated to cater to these cooling requirements. This involves considering factors that enhance energy efficiency and minimize the need for excessive cooling.

[29] **Getu Hailu**,Energy systems in buildings, Energy Services Fundamentals and Financing, 2021

[30] Energy-Efficient Building in a Hot Climate, https://www.foxblocks.com/a-guide-to-designing-an-energy-efficient-building-in-a-hot-climate

Building envelope systems are typically categorized as either "tight" or "loose." A tight building envelope minimizes air leaks, achieved through meticulous insulation, sealants, and energy-efficient windows. Why strive for such a tight seal? It grants occupants greater control over the indoor environment, ensuring comfort and energy efficiency.[31]

In hot climates like Pakistan's, the design of an energy-efficient building must focus on preventing air and moisture infiltration and reducing heat gains. Achieving this involves creating a tight building envelope, as well as thoughtful considerations such as building orientation, size, shape, and the selection of appropriate windows and doors. These elements together contribute to a building's ability to combat the challenges posed by high temperatures and ensure a comfortable indoor climate.



a) External energy source e.g. fossil energy.
b) Renewable energy from e.g. solar collectors.
c) Solar gain.
d) Electrical devices e.g. television, kitchen aids
e) Warmth from humans and pets.
f) All energy will eventually leaving the building.

Figure 9: Illustration of the flow of energy through a building. The amount of energy supplied from an external source is less than the total heat loss of the building, because occupants, electrical devices and especially windows add "free" energy.[32]

6. GREEN BUILDING TRANSFORMATION: TECHNOLOGY OPTIONS AND PATHWAYS

In Pakistan, traditional construction practices often avoid the incorporation of efficient and green technologies. Upfront cost is a major consideration when it comes to the selection and integration of sustainable and efficient technologies in Pakistan. For most consumers, especially in a developing economy like Pakistan, the upfront expenses associated with adopting these technologies can be a significant barrier. Many households and businesses operate on tight budgets, making it challenging

[31] What Is a Building Envelope and Why Is It Beneficial? https://www.bigrentz.com/blog/building-envelope
[32] Energy use in buildings, Velux (https://www.velux.com/what-we-do/research-and-knowledge/deic-basic-book/energy/energy-use-in-buildings

to justify the initial investment in green technologies, even though they offer long-term savings and environmental benefits.

Green building technologies cover across both the construction and operational phases of green buildings and offers a comprehensive approach to sustainable development. Below are some technology options for Pakistani Green Building Market often used in Green Buildings worldwide.

Sustainable Construction Materials: Green buildings prioritize the use of sustainable construction materials that offer better thermal insulation and reduce heat absorption. Examples include recycled materials, thermal mass construction, and reflective surfaces.

Green Insulation: Green buildings incorporate insulation materials that provide high thermal resistance, helping to maintain cooler indoor temperatures and reduce the need for excessive air conditioning.

Variable Drives: Variable drives and efficient Heating, Ventilation and Air Condition (HVAC) systems enable precise control of air conditioning and ventilation, optimizing energy use.

Efficient Windows: Energy-efficient windows with low solar heat gain coefficients allow natural light while blocking excess heat, reducing the reliance on artificial lighting and cooling systems.

Cool Roofs: Cool roofs are designed to reflect sunlight and absorb less heat and these are highly effective in hot climates. Cool roofs keep buildings cooler, thus reducing the overall cooling load.

Low Emitting Materials: Green buildings prioritize low emitting materials which release fewer volatile organic compounds (VOCs). This not only improves indoor air quality but also reduces the heat generated by off-gassing materials.

Efficient Heating, Ventilation, Air Conditioning (HVAC): High-efficiency HVAC systems with advanced controls ensure precise temperature control, reduce energy consumption and enhance indoor comfort.

Solar Panels (Passive and Active): Solar panels are a key feature in green buildings for both passive and active design elements, such as optimum shading and orientation, maximize natural cooling, while active solar panels harness the solar radiation for onsite energy generation.

Automation, Controls, and Building Monitoring: Advanced automation and control systems help optimize energy use by adjusting lighting, HVAC, and other systems based on occupancy and outdoor conditions.

Efficient Lighting: Efficient lighting solutions, including LED technology and occupancy sensors, reduce electricity consumption.

Water Conservation: Water-efficient fixtures and systems ensure water resources conservation and efficiency. Green buildings incorporate low-flow faucets and rainwater harvesting systems to minimize water consumption.

COST BENEFIT OF ANALYSIS OF GREEN BUILDINGS TECHNOLOGY MEASURES

The majority of research on the advantages of green buildings primarily stems from studies concentrated on developed economies. In contrast, there exists a limited amount of well-structured data regarding green buildings and their economic merits within developing nations, including Pakistan. Green buildings are characterized by their superior efficiency compared to conventional buildings, and have the potential to decrease operational expenses, boost income streams, and mitigate the risks associated with both the physical and transitional aspects of climate change. This section investigates into multiple case studies that underscore the business rationale and economic advantages of adopting green building technologies, particularly the building insulation, solar PV integration and efficient lighting.

BUILDING INSULATION IMPACT ON ENERGY AND COST SAVINGS IN HOT CLIMATES: SAUDI CASE STUDY

Building insulation plays a pivotal role in enhancing the energy efficiency and overall sustainability of structures. In this comprehensive analysis, we evaluate four distinct insulation strategies, ranging from having no insulation to insulating either the roof or walls individually, and a combination of both. The primary focus is on quantifying the benefits of building insulation, particularly in terms of cost and energy savings.

Since there is a limited information and reliable data on case studies on impact of building insulation on energy and cost savings in Pakistan, we have examined a case study in Saudi Arabia, which shares similar climate characteristics with Pakistan. It could provide valuable insights into the impact of building insulation on energy and cost savings in hot climatic conditions. Such case studies can help inform decisions related to insulation strategies for residential buildings in Pakistan and other regions with comparable climates.

Alternative insulation strategies	**No insulation (BC)**	**Insulated roof only**	**Insulated walls only**	**Insulated roof and walls**
Optimum thickness (cm)	0	8	4	6
Energy consumption kWh/sq.m/y	193.07	156.11	178.57	135.59
Percentage of conserved energy (%)	0	19.14	7.51	29.77
Cost of consumed energy in 30 years	68,926.0	5,5731.3	63,749.5	48,405.6
Cost of conserved energy/year	0	439.8	172.6	684.0

Cost of optimum thickness $/sq.m	0	1642.7	2094.4	4373.7
Cost saving (%)	0	16.8	4.5	23.4
Payback period (years)	0	3.73	12.14	6.39
CO2 emission (kg/year)	12,742.1	10,393.7	11,563.7	8,868.4

Table 7: Cost Benefit Analysis of Building Insulation on energy and cost savings, and corresponding payback period.[33]

This table provides a comparison of different insulation strategies for a building with insulted roof only, insulated walls only and insulations of roof and wall, evaluating them based on various factors such as energy consumption, cost, energy conservation, CO2 emissions, and payback period.

The building under consideration is a residential building; a detached family house. The residential building consists of two storeys and has a total built floor area of 238 square meters. Additionally, it is situated on a land area measuring 500 square meters.

ELECTRICITY SAVINGS DUE TO IMPROVED BUILDING INSULATION

1. **No Insulation (BC)** Without any insulation, energy consumption is the highest at 193.07 kWh/sq.m/year. This energy inefficiency translates into higher utility bills and increased environmental impact, with CO2 emissions of 12,742.1 kg/year.
2. **Insulated Roof Only** By insulating just the roof with an optimum thickness of 8 cm, energy consumption drops to 156.11 kWh/sq.m/year, resulting in a 19.14% reduction in energy use. This reduction significantly cuts both energy bills and CO2 emissions (10,393.7 kg/year).
3. **Insulated Walls Only** Insulating only the walls (4 cm thickness) reduces energy consumption to 178.57 kWh/sq.m/year, a 7.51% reduction, with corresponding cost and CO2 emission savings.
4. **Insulated Roof and Walls** The most effective strategy is insulating both the roof and walls (6 cm thickness), resulting in the lowest energy consumption of 135.59 kWh/sq.m/year, a

[33] Nedhal Al-Tamimi, "Cost Benefit Analysis of Applying Thermal Insulation Alternatives to Saudi Residential Buildings", Journal of Engineering Sciences Assiut University (2021) https://jesaun.journals.ekb.eg/article_147213.html

remarkable 29.77% reduction compared to no insulation. The CO2 emissions are also the lowest at 8,868.4 kg/year.

Characteristics	Description
Number of floors	2
Gross floor area	238 m^2
Gross wall area	357 m^2
Gross roof area	140 m^2
Window-to-wall ratio	6.1%
External wall construction (from outside to inside) *(U-value: 1.650 W/m2-K)*	20 mm-thick plaster 200 mm-thick concrete blocks 20 mm-thick plaster (light)
Internal partition construction	20 mm-thick plaster (light) 150 mm-thick concrete blocks 20 mm-thick plaster (light)
Roof construction (from outside to inside) *(U-value: 3.644 W/m2-K)*	20 mm-thick cemented tiles 15 mm-thick mortar 50 mm-thick sandstone 150 mm-thick reinforced concrete 13 mm-thick plaster (light)
Ground floor construction	12 mm-thick ceramic tiles 15 mm-thick mortar 100 mm-thick light reinforced concrete 150 mm-thick base-course stone
Type of glass *(U-value: 5.778 W/m2-K)*	6 mm-thick single clear
Number of occupants	6
Lighting power density	4.0 W/m^2
Appliance power density	3.5 W/m^2
Cooling set point	24 °C
HVAC system (*CoP: 2.17*)	DX air-cooled A/C system with electric thermostat

Table 8: Building Characteristics of residential detached house under analysis for examining the impact of building insulation.

COST SAVINGS AND PAYBACK PERIOD

1. **Insulated Roof Only** Insulating the roof reduces the cost of consumed energy to $55,731.3 over 30 years, saving $13,194.7. This represents a cost saving of 16.8%, with a relatively short payback period of 3.73 years.
2. **Insulated Walls Only** While insulating only the walls results in cost savings of $7,176.5 over 30 years, the payback period is longer at 12.14 years. The cost saving percentage is 4.5%.
3. **Insulated Roof and Walls** This strategy yields the highest cost savings, with a total of $48,405.6 saved over 30 years, representing a substantial 23.4% cost reduction. The payback period is also relatively short at 6.39 years.

This analysis demonstrated that insulating both the roof and walls is the most effective strategy in terms of energy conservation, with a 29.77% reduction in energy consumption compared to no

insulation. This strategy also leads to the lowest CO2 emissions and the shortest payback period, indicating its environmental and economic benefits. Insulating the roof only is the second-best option, with significant energy savings and a reasonable payback period. Insulating walls only provides moderate energy savings and has the longest payback period. While no insultation results in the highest energy consumption, costs, and CO2 emissions.

COST-BENEFIT ANALYSIS FOR SOLAR PV INSTALLATION ON A COMMERCIAL BUILDING IN PAKISTAN

Solar panels are a key feature in green buildings for both passive and active design elements, such as optimum shading and orientation, maximize natural cooling, while active solar panels harness the solar radiation for onsite energy generation. It is important to underline the financial aspects of installing a solar photovoltaic (PV) system.

Solar PV integration is a key feature of green buildings and aligns perfectly well with global sustainability goals, reducing energy consumption and costs, and contributing to environmental conservation. Many green building certifications such as LEED often requires the inclusion of renewable energy sources like solar PV. As Pakistan continues to address its energy demand and environmental challenges, the adoption of solar PV systems in construction projects holds immense potential to create a more sustainable and resilient built environment while offering economic benefits to building owners and occupants.

The cost benefit analysis of integration of Solar PV is straight forward in Pakistan. We will underline the financial merits of implementing a solar photovoltaic (PV) system in a commercial building located in Pakistan as an integrated feature of green building. Our proposal suggests the installation of a 50 kW as grid connected solar PV system will require an initial investment of US$50,000. We assume the cost of solar system, including installation at US$1,000 per kW. Considering Pakistan's solar PV capacity factor, averaging around 25%, a 50-kW solar PV system is projected to generate 107,310 kWh of electricity annually.

The first step in our cost-benefit analysis is to determine the annual savings realized through the solar PV system. Given that the system generates 107,310 kWh of electricity annually at 25% capacity factor, the annual cost savings can be calculated as follows:

- Annual Savings = Solar PV Electricity Production × Cost of Electricity from Grid
- Annual Savings = 107,310 kWh × $0.15/kWh (PKR 45/kWh) = $16,096.50 (or 4,819,950 PKR at US$-PKR exchange rate of 300)

Hence, the solar PV system is expected to deliver annual savings of approximately US$ 16,096.50 or PKR 4,819,950 by reducing the need for grid electricity assuming the average cost of US$ 0.15 per kWh of grid electricity.

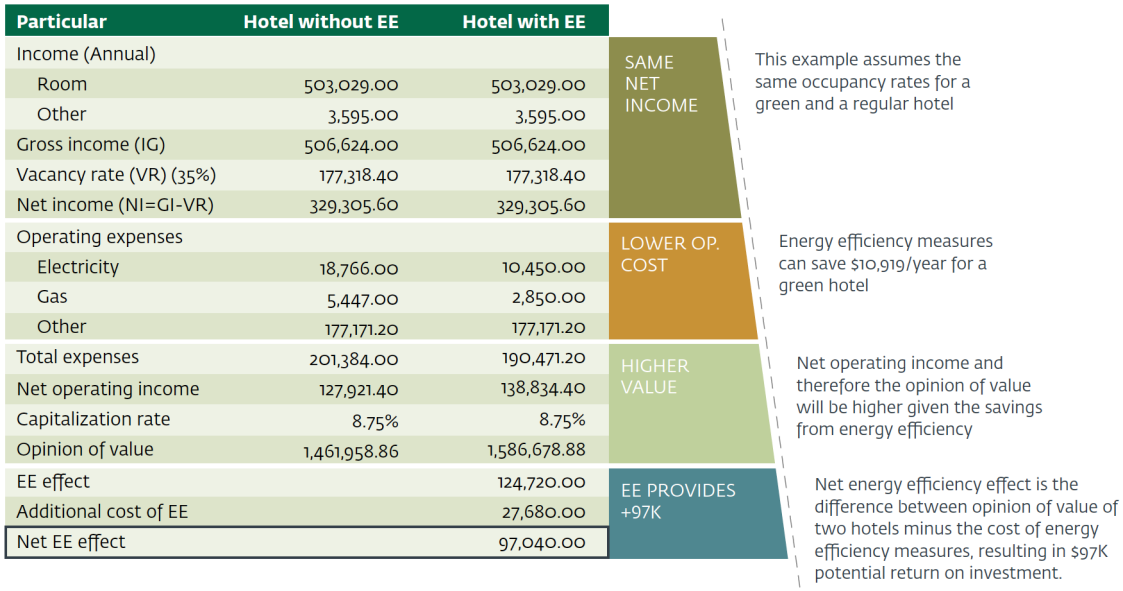
The payback period is a crucial metric that indicates when the initial investment is recovered through the annual savings. In this scenario, the payback period for installing a 50-kW solar PV system is calculated as follows:

- Payback Period = Initial Investment / Annual Savings

- **Payback Period** = $50,000 / $16,096.50 ≈ **3.10 years**

Generally, the expected lifespan of a solar PV system is 25 years, the total savings could accumulate to several hundred thousand dollars over 25 years duration, underscoring the long-term financial advantages of this solar PV system. Hence, this demonstrates that substantial economic benefits of incorporating solar PV technology into commercial buildings in Pakistan as an integrated feature of a green building. Not only does it contribute to sustainability efforts, but it also yields impressive cost savings, making it an attractive and environmentally responsible investment option for commercial property owners.

Likewise, widespread use of LED lighting will have a substantial impact on energy savings, as they offer substantial savings in comparison to incandescent lighting. Hence, installing LEDs is one of the most cost-effective options for reducing energy intensity in buildings with shortest payback period within the range of 1-2 years.



Particular	Hotel without EE	Hotel with EE
Income (Annual)		
Room	503,029.00	503,029.00
Other	3,595.00	3,595.00
Gross income (IG)	506,624.00	506,624.00
Vacancy rate (VR) (35%)	177,318.40	177,318.40
Net income (NI=GI-VR)	329,305.60	329,305.60
Operating expenses		
Electricity	18,766.00	10,450.00
Gas	5,447.00	2,850.00
Other	177,171.20	177,171.20
Total expenses	201,384.00	190,471.20
Net operating income	127,921.40	138,834.40
Capitalization rate	8.75%	8.75%
Opinion of value	1,461,958.86	1,586,678.88
EE effect		124,720.00
Additional cost of EE		27,680.00
Net EE effect		97,040.00

Figure 10: Green hotel value example (India) Effects of energy efficiency (EE) on the value of a hotel (USD)

Figure 10 above demonstrates a case of hotel value chain in India with lower operating costs due to energy savings can help increase the valuation of green buildings. It demonstrates as to how energy efficiency could increase the valuation of a green hotel by 6.6 percent.

CULTIVATING A GREEN-TECH WORKFORCE FOR GREEN BUILDING IN PAKISTAN

It is essential to emphasize the critical need for capacity development and skills enhancement in Pakistan's construction industry. To effectively incorporate the green building technologies mentioned above, there is a significant requirement for a proficient cadre of technical human resources. This would require providing a continuous, rigorous and adequate training and education to architects, engineers, contractors and other construction professionals who play pivotal roles in the design, development, and implementation of these technologies.

Building a skilled workforce capable of deploying the potential of sustainable construction materials, energy-efficient systems, and eco-friendly practices would be critical in the successful adoption of green building technologies. These measures would not only enhance the Pakistan's technological capabilities but also develops a culture of innovation and excellence in the construction sector leading to contributing to a greener and sustainable built environment.

7. GREEN BUILDING CERTIFICATIONS IN PAKISTAN: FINDING THE RIGHT FIT

Green building certification programs have played an important role in expanding the market for sustainable and green construction practices. They accomplish this by evaluating and benchmarking building achievements across various dimensions of sustainability, including energy efficiency, design, construction, and operational performance. These programs offer an essential layer of validation through third-party verification and certification.

Globally, notable certification programs like Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environut Assessment Method (BREEAM), and Excellence in Design for Greater Efficiencies (EDGE) have gained widespread adoption in the building and construction industry. Besides, many countries have developed their own building certification systems gaining inspiration from BREEAM and LEED while tailoring them to address local priorities and market conditions. Over 85 countries have adopted national or local building certification programs, which can be voluntary or mandatory for all or part of the buildings sector. Figure 11 provides a comparative overview of three prominent international certification programs: LEED, BREEAM, and EDGE. It illustrates the diversity in their approaches, areas of focus, and the extent of their adoption across different systems.

Certification system and managing organization		Building Research Establishment Environmental Assessment Method (BREEAM)—BRE Global†	Excellence in Design for Greater Efficiencies (EDGE)—International Finance Corporation‡	Leadership in Energy and Environmental Design (LEED)—U.S. Green Building Council§
Type of certification		Green building rating and certification system through on-site independent third-party verification for new construction, in-use, refurbishment and fit-out, commercial interiors, core and shell, schools, retail, healthcare, homes, communities, and infrastructure	Online platform to determine cost-effective options for designing green within a local climate context, a green building standard, and a certification system for new construction, existing buildings, and major retrofits of commercial/residential structures	Green building program for buildings, communities, and cities, providing a rating and certification system through second-party verification for new construction, existing buildings, operations and maintenance, commercial interiors, core and shell, schools, retail, healthcare, homes, neighborhood development, and cities
Areas of focus		Weighted performance in 9 categories with minimum standards: Energy, health and wellbeing, transport, water, materials, waste, land use and ecology, management, and pollution No prerequisites for in-use	Independent certification for projects achieving EDGE standard of 20% less energy use, 20% less water use, and 20% less embodied energy in materials compared to a base case building EDGE Advanced certification for >40% energy savings, with at least 20% savings in water and materials EDGE Zero Carbon for 100% carbon neutrality, with >40% energy efficiency required on-site	Performance across 9 categories scored out of 110 points: Sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, locations and linkages, awareness and education, innovation in design, and regional priority through a set of prerequisites and credits
Number of countries covered		83	154	176
Total number of projects certified by building type	Residential	1,648	169	34,632
	Office	5,240	41	19,236
	Retail	3,231	454	7,640
	Education	2,506	8	6,035
	Hospital	730	8	1,353
	Hotel	Included in Other	18	846
	Other	8,187	6	10,987
Total floor area registered (m^2)		1,060,000,000	16,304,630	1,291,791,279
Total floor area certified (m^2)		235,000,000	7,697,001	806,871,943

Figure 11: Selected widely used international green building certification programs. (Source: International Finance Cooperation – IFC)

In case of Pakistan, the Pakistan Green Building Council (PGBC) has introduced its own rating system known as SEED (Sustainability in Energy and Environmental Development), which was first published in October 2016. SEED is a localized and tailored version, inspired by the LEED certification system for Pakistan and is designed to promote sustainable and socially responsible practices in the planning, construction, maintenance, and operation of buildings and communities. SEED offers four tiers of certification based on the points earned by a building: silver, gold, platinum, and titanium, with titanium being the highest achievable certification level, indicating the highest level of sustainability and environmental performance. PGBC has certified a couple of iconic buildings in Pakistan with SEED certification, which include the Parliament House and President House in Islamabad.

CHALLENGES IN GREEN BUILDING CERTIFICATION FOR PAKISTAN

The limited adoption of PGBC's SEED certification system can be attributed to a lack of a coherent and integrated approach among various policy and regulatory stakeholders. One significant reason for this limited adoption is that PGBC, as a non-state entity, has not gained the necessary support and recognition from major industry players and regulators. It's worth noting that successful certification systems, such as the Indian Green Building Council operate as non-governmental and not-for-profit institution.

Another challenge in the building industry is the proliferation of various institutions attempting to develop their own building codes and guidelines. This has resulted in multiple codes being established but with little to no enforcement. To address this issue, it is essential to establish a framework where key stakeholders share responsibilities and collaborate effectively.

A robust institutional arrangement is required, where policy and regulatory organizations like NEECA, PEC, and relevant ministries work closely with implementing agencies to develop a unified building certification system. The responsibility for enforcing these building codes rests with implementing agencies such as municipal corporations, metropolis development authorities, provincial building control departments, and real estate developers.

The Pakistan Green Building Council (PGBC) could play a crucial role by serving as an accredited body for certifying green buildings and acting as a bridge between policy and regulatory institutions and implementing agencies. Additionally, there is a need for capacity building at both the policy and regulatory levels, as well as within implementing agencies to ensure the effective implementation of green building practices and codes.

BRIDGING THE GAP BETWEEN BUILDING REGULATIONS AND IMPLEMENTATION IN PAKISTAN

In Pakistan, the challenge of promoting building energy efficiency and green construction practices lies not in the development of regulations but in their effective enforcement. Despite various initiatives to establish energy-efficient building codes and green building frameworks, these efforts have often failed to translate into on-ground implementation.

Key institutions like the National Energy Efficiency and Conservation Authority, Pakistan Engineering Council and relevant Ministries of Energy and Climate Change have made strides in creating these codes, but they remain largely unimplemented at the local level, where construction projects are carried out. The top-down approach taken by these policy interventions has overlooked the practical challenges and complexities faced by local developer.

To address this issue, a more pragmatic approach is needed, focusing on direct collaboration with local authorities in major cities like Islamabad, Lahore, or Karachi. Initiating pilot programs in collaboration with the Capital Development Authority in Islamabad, for example, can serve as a valuable testing ground for green building codes. Successes and lessons learned from these pilots can then be extended to other urban areas in Pakistan, ensuring that energy efficiency and green construction practices are not just words on paper but integral components of the country's building sector.

FROM GENERIC TO SPECIFIC: ENERGY EFFICIENT AND GREEN BUILDING CODE FOR PAKISTAN

One of the limitations in developing green building and energy-efficient codes is their one-size-fits-all approach. These regulations often attempt to apply the same standards to all building types, whether they are schools, commercial offices, high-rises, residential apartments, or single-family homes. This lack of differentiation can hinder the effectiveness of these codes.

Looking to the Indian Green Building Construction Industry as a model, we can see how they have evolved by developing distinct ratings for different building types. They have created separate rating systems for green homes and low-income housing to cater to specific needs. Moreover, they have gone even further by developing separate rating standards for various commercial building types, including new buildings, existing buildings, healthcare facilities, data centers, schools, and offices. Pakistan can benefit from this approach by creating case-specific green building codes for each building type.

To achieve this, a bottom-up approach to developing green building codes is essential. Urgent action is needed to not only adopt policies requiring existing and new buildings to meet green building criteria but also to establish and enforce relevant laws and regulations for their effective implementation. These laws should offer incentives to commercial builders, such as tax benefits and expedited permits, while penalties should be imposed where necessary to ensure compliance with green building standards. This comprehensive approach is crucial to drive the adoption of green building practices in Pakistan.

Figure 12: Green Building Certification of Parliament House of Pakistan. Source Pakistan Green Building Council.

THE NEED FOR BUILDING ENERGY USE BENCHMARKS IN PAKISTAN

One crucial step in promoting energy efficiency in buildings is establishing baseline energy use benchmarks for different building types. Unfortunately, Pakistan has yet to conduct a comprehensive benchmark analysis for energy use in various types of buildings.

Benchmarking when applied to building energy use, serves as a valuable tool to measure a single building's energy performance over time, relative to similar buildings, or to modeled simulations of a reference building built to specific standards like energy codes. This practice offers benefits to regulators, building owners, facility operators, managers, and designers.

Benchmarking facilitates energy accounting, allowing facilities to compare their energy use with similar ones to identify opportunities for improvement and quantify or verify energy savings. In the commercial building sector, energy performance benchmarking has become a standard practice, especially as rising energy costs and environmental concerns emphasize the importance of energy management. To effectively manage energy use, it's essential to measure and benchmark it accurately.

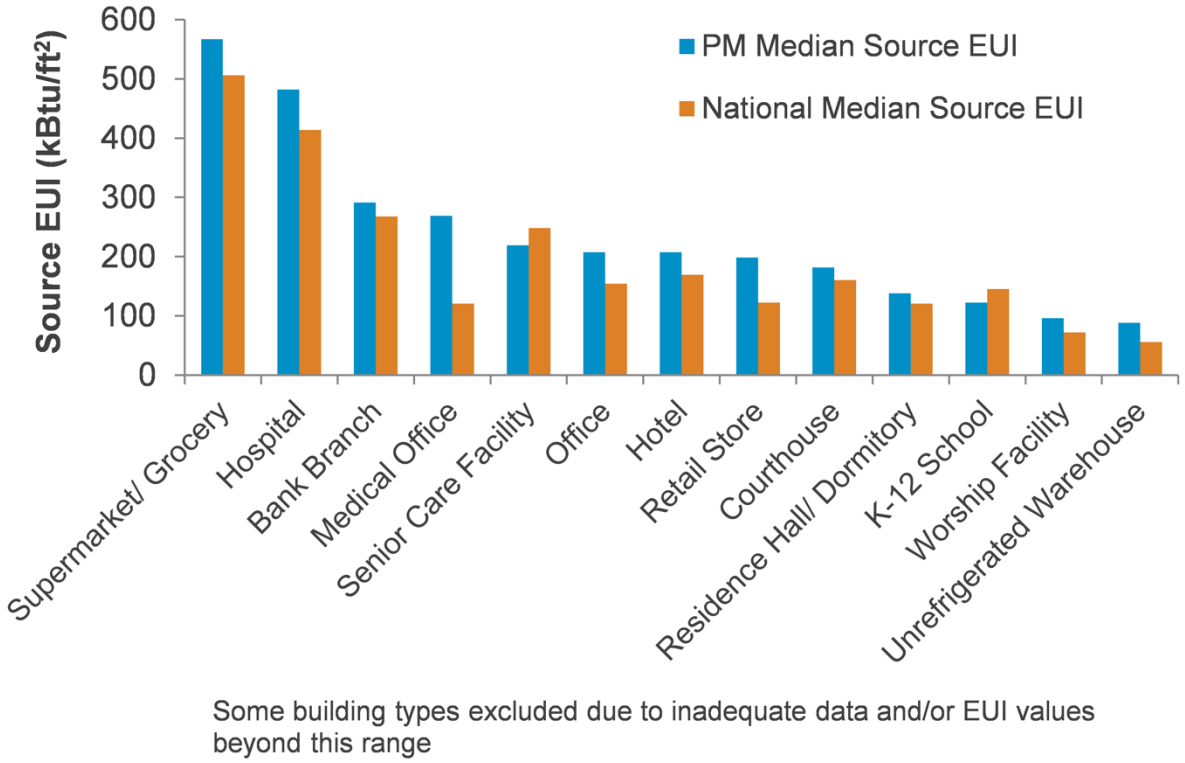


Figure 10: Typical EUI for selected buildings. This graph is based on research EPA conducted on more than 100,000 buildings (Source: https://duanetilden.com/2016/12/19/benchmarking-buildings-by-energy-use-intensity-eui/)

After implementing effective benchmarking and acquiring comprehensive data on the energy use intensity of various building types, this valuable information can serve as a baseline for assessing energy efficiency. Building upon this foundation, the establishment of a performance-based energy efficiency rating system becomes both feasible and beneficial.

This rating system would allow for a robust evaluation of a building's energy performance, taking into account factors such as energy consumption patterns, sustainability practices, and resource efficiency. By moving beyond simplistic metrics and adopting a performance-based approach, regulators in Pakistan could provide building owners and stakeholders with a more accurate and comprehensive assessment of their buildings' energy efficiency. This, in turn, can incentivize further investments in green technologies and practices, ultimately driving the adoption of energy-efficient building solutions across the country

POLICY RECOMMENDATIONS ON PROMOTING GREEN BUILDING CERTIFICATION IN PAKISTAN

1. **Benchmarking and Data Collection**

   Benchmarking is a foundational step toward managing and improving energy efficiency before we begin developing any further green building codes or energy efficiency codes. NEECA, PEC,

and PEECA along with development authorities and building control units should work together to develop a comprehensive benchmarking program to assess the energy performance of different building types. This will require establishing a baseline and collecting data on energy use in various sectors.

2. **Tailored Green Building Codes and Certification Programs for Pakistan's Specific for Building Types**

   Instead of adopting generic international codes and green building certification programmes, develop customized green building codes specific to different building types (e.g., residential, commercial, industrial) building upon the existing international codes and guidelines. We can learn from international best practices, such as the Indian Green Building Council's approach, and apply a bottom-up methodology for code development.

3. **Enforcement of Building Energy Codes by empowering Implementing Agencies**

   The foremost challenge in Pakistan lies in the enforcement of existing building energy codes. Policy makers should prioritize and ensure the effective implementation of these regulations at the local level. This requires collaboration with development authorities and building control departments at local and provincial levels to make compliance mandatory for all new construction and renovations.

4. **Pilot Green Building Programs using Bottom-Up approach with key implementing agencies and institutions.**

   Launch pilot programs focused on green building initiatives in major urban centres like Islamabad, Lahore, and Karachi. These areas can serve as testing grounds for implementing and refining green building codes and practices. Successful outcomes can then be scaled up to other regions.

5. **Incentives and Penalties**

   Introduce financial incentives for developers and builders who adhere to green building standards. This could include tax benefits, expedited permit approvals, and other rewards. Simultaneously, impose penalties for non-compliance with energy efficiency and green building regulations to create a stronger deterrent.

6. **Local Green Building Product Manufacturing**

   Collaborate with the green building construction industry to promote the local production of green building products and materials. Support research and development efforts to innovate sustainable construction materials that align with the specific needs and climatic conditions of Pakistan. Establish partnerships with local manufacturers to ensure the availability and affordability of these eco-friendly materials.

7. **Sourcing Green Materials**

   Work with industry experts, builders, manufactures and academia to establish green supply chain with local manufacturers and facilitate the sourcing of green building materials through sustainable supply chains. Encourage builders and developers to prioritize the use of locally

sourced and environmentally friendly materials in their projects. Provide guidance and incentives for incorporating recycled, renewable, and low-impact materials into construction practices.

8. **Capacity Building and Training**

   Invest in capacity development and skills training to build a proficient workforce capable of designing, implementing, and maintaining green building technologies. Collaborate with educational institutions and industry associations to offer relevant training programs.

9. **Public Awareness and Education**

   Launch public awareness campaigns to educate the general population about the benefits of green buildings and energy-efficient practices. Foster a culture of sustainability and encourage individuals to make eco-conscious choices in their homes and workplaces.

10. **Stakeholder Collaboration is the key to promoting green and sustainable buildings.**

    Collaborate closely with stakeholders at all levels, including government agencies, industry associations, environmental organizations, and international partners. Formulate a cohesive strategy that leverages the strengths and resources of each stakeholder group.

11. **Robust Monitoring and Evaluation Framework for Energy Efficient and Green Buildings**

    Establish a robust monitoring and evaluation system to track the impact of energy efficiency and green building policies. Periodically assess the effectiveness of these policies and make data-driven adjustments if needed.

12. **International Collaboration and Learning from other successful regional initiatives.**

    Engage in international collaboration and knowledge sharing with countries that have successfully implemented energy efficiency and green building initiatives. Learn from their experiences and adapt relevant strategies to the Pakistani context.

8. CONCLUSION

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. In a rapidly urbanizing nation of approximately 230 million people, where the construction sector significantly contributes to energy consumption and greenhouse gas emissions, the need for green buildings is extremely critical. The transition to green construction not only aligns with global sustainability practices but also contributes to energy conservation, reduced GHG emissions, and improved living conditions in Pakistan.

Pakistan's construction and building sector plays a pivotal role in the nation's economic landscap. The sector faces both challenges and opportunities in its transition towards green building practices and energy-efficient construction.

With a burgeoning population, rapid urbanization, and increasing energy demands, the need for sustainable and environmentally responsible building practices has never been more pressing. Green buildings, which prioritize energy efficiency, resource conservation, and environmental responsibility across their entire lifecycle, offer a promising solution to mitigate the environmental impact of the construction industry.

However, several hurdles impede the widespread adoption of green building practices in Pakistan, primarily due to high initial costs, limited access to sustainable construction materials, a shortage of skilled labor, and an overarching emphasis on energy efficiency and comprehensive green building practices in existing policies.

Robust green and sustainable building policies are vital to incentivize the production and use of low-carbon construction materials, aligning with Pakistan's ambitious carbon neutrality goals outlined in its Nationally Determined Contributions (NDCs).

The construction and building sector, with its significant contribution to energy consumption and GHG emissions, requires strong policy support for the adoption of green building practices. The journey towards a greener and more sustainable built environment demands collaboration among policymakers, industry stakeholders, civil society, and the public.

Efforts must focus on strengthening regulatory frameworks, including building energy codes, raising public awareness, improving access to sustainable materials, enhancing skills through capacity development, and offering financial incentives to offset initial costs. Monitoring, evaluation, and local government engagement would also be vital to enforce building energy codes and promote green practices at the grassroots level.

Furthermore, research and development initiatives should be encouraged to tailor cost-effective green building technologies to Pakistan's diverse climate and building typologies. International collaboration and public-private partnerships could provide valuable insights and investment opportunities.

In achieving these goals, Pakistan can expedite its transition to a greener, more sustainable built environment, contributing to global sustainability objectives while reaping economic, environmental, and societal benefits. As the nation continues to experience the rapid urbanization and high energy demands, the adoption of green building practices emerges as an opportunity for Pakistan towards sustainable economic and development growth.